BRIEFER ARTICLES.

ULVELLA AMERICANA.

(WITH PLATE VII)

Ulvella Americana, n. sp.—This form was found with Nitella and Œdogonium near Ann Arbor, Mich., and grew in great abundance on the sides of the glass of a small aquarium in which these algæ were growing.

Though it was found in shallow fresh water at a great distance inland, it undoubtedly belongs to the marine genus Ulvella, the only other known species of which, *Ulvella lens*, was first found by the Crouan brothers in 1859, growing on bits of glass, porcelain, and seaweeds, at a depth of twenty meters in the bay of Brest in France. It has also been found by Hansgirg in several places in the Adriatic sea.

The Messrs. Crouan[1] describe the genus as follows: Thallus green, disk-shaped, 1–2^{mm} in diameter, horizontal, adhering by all its under surface, composed at the center of cells round, ovate or angled, imbedded in a subgelatinous substance, reticulated, and containing in the interior several sporidia. Toward the periphery the cells change to ovoid or rectangular, are much smaller, separated, and arranged in radiating lines either simple or forked at their extremities. A vertical section of the thallus shows the cells to be arranged in almost perpendicular series, and filled with green.

In addition to this description De Toni[2] states that the cells are 12 to 18 μ (rarely 21 μ) in diameter; also that it reproduces by means of zoospores. These are formed in the central cells, 4, 8, or 16 in each, and are liberated by the dissolving of the membrane. According to Wille,[3] however, this is a doubtful genus, as he thinks it might belong to the genus Pringsheimia; but the structure of the chromatophore and the absence of gametes must separate it from this genus, and so the name Ulvella will be retained.

[1] Crouan frères, Ann. d. Sci. Nat. Bot. IV. **12**: 288. 1859.

[2] De Toni, Sylloge Algarum **1**: 148. 1889.

[3] Engler & Prantl, Die nat. Pflanzenfamilien I. **2**: 105. 1890.

Whether this fresh water form is the same species as the marine form is difficult to say, but it would seem that there were differences great enough to make a new species. Certainly in this form there is much less difference in size between the central and peripheral cells than that figured by the Crouan brothers. Also, in quite a number of cases, long gelatinous looking hairs extended from the surface, and a pyrenoid is always present. As these points seem to be characteristic of the fresh water form only it seems best to separate it from *U. lens*, and to make a new species.

In appearance this fresh water species resembles greatly *Coleochaete scutata*, but the absence of all differentiated sexual organs, the presence of many chromatophores instead of one, and the fact that 4, 8, or 16 zoospores may be found in a single cell of the thallus, all indicate that the nature and development are quite different from that genus

The disk-shaped thallus varies from 1–3^{mm} in diameter, and until it is partly grown it consists of a single layer of cells arranged in radial rows about a center (*fig. 1*). In surface view the cells near the margin are either square, elongated, or wedge-shaped in outline. They vary in length from 10 to 27 μ, and in breadth from 5 to 13 μ. At the center they are nearly circular, and their diameter is 10 to 13 μ. In cross section the appearance is reversed; the cells near the edge being short or flattened (*figs. 2* and *4*), and those at the middle much elongated, their longest diameter being at right angles to the plane of the disk (*figs. 2* and *3*). The whole thallus does not remain in contact with the substratum throughout its life, but while it is still quite small the central cells become loosened from beneath, then increase in size and number so that the whole center arches up above the level of the disc, and often becomes folded in circles between the center and the periphery. Soon division occurs in these cells parallel to the plane of the thallus, so that at the center several layers may be observed (*fig. 5*).

The membrane is gelatinous, though the layer bounding the contents of the cell is more dense than other portions. Neither the gelatinous substance nor the denser membrane shows a blue color either with chloriodide of zinc or with iodine and sulfuric acid. Both become stained with hæmatoxylin, but not with eosin.

So far as was observed, after the first few divisions only periclinal divisions occurred; even new radial rows of cells originated in this way, one or more projections, occurring on the exterior side of the cell, being then cut off by transverse walls. The long gelatinous hairs observed in the material from the aquarium disappeared in smaller cultures.

The chromatophores, of which there are many in each cell, are small oval bodies closely crowded near the membrane and imbedded in a highly refractive, almost gelatinous looking, liquid. Whether this is simply the protoplasm which surrounds all chromatophores, or whether it is of some special composition was not determined. A single pyrenoid is present near the middle of each cell, and this is surrounded by a starch envelope, somewhat irregular on the surface. The nucleus lies near the pyrenoid, and assumes more or less the shape of the cells in which it exists; that is, in the peripheral cells it is nearly spherical, while in the central cells it is elongated.

Though a disk shape is characteristic of the species when attached to some solid substratum, it is by no means necessary to the plant, and seems to be assumed only when the plant is attached. If it become detached (and it seems to be capable of living indefinitely in this condition), the whole thallus loses all symmetry of structure, and forms simply an irregular mass of cells the same as is noticed when the central portion becomes loosened from the substratum. If a plant be removed from the surface of the glass and put into a hanging drop culture, either in water or in Knop's solution, there occurs an immediate elongation of the cells perpendicular to the plane of the disk, and they stand up, papilla-like, over the whole surface, even at the edge where the cells had been most flattened. In one instance, within four days, division parallel to the plane of the disk had occurred in these cells, and these again divided in all directions, so that the surface of the disk was then covered with little clusters of cells without the least regularity of arrangement, each cluster leading an independent existence (*fig.* 6).

The same holds true if the development be watched from the zoospores. If these become attached on coming to rest the characteristic disk-form is produced (*figs.* 7, 8), but if they rest on the surface of the liquid, or if they rest on a substratum less solid than glass, such as agar, then the development is identical with that when the mature thallus is detached from a solid substratum, except that the cells become somewhat larger, ranging in diameter from 13 to 23 μ (*figs.* 9–12). Division occurs in these cells rather irregularly. A wall may divide a cell into equal or unequal parts, while in other cases one or two parallel projections are sent out, and these are cut off by transverse walls (*fig. 12*).

Although the plant may be kept under cultivation as a unicellular alga for a period of at least three months, evidently the normal state is a disk form, for, though development in the unicellular condition was very rapid for the first few days, it soon decreased and almost ceased. This slow development is true also of the thalli arising from the zoospores when unattached; they never attain a large size, but this may be due to unfavorable culture methods.

Of different culture media tried, water, various concentrations of Knop's solution, vegetable solution, and agar to which had been added Knop's solution, the last medium proved most favorable, and development, though slow, was evident as long as the cultures were continued.

Reproduction other than by means of zoospores and vegetative division was not observed.

The zoospores (*fig. 13*) are oval or nearly spherical, though sometimes more elongated and slightly broader near their anterior extremity (*fig. 14*). They are 10.5–15.5 μ long and 7.8–13 μ broad. Usually they do not exceed 10.5 μ in breadth. They are noticeable for their very granular appearance, which is due to the presence of globules of oil; these become darkened by osmic acid, and dissolved by chloroform. On account of the great quantities of this oil the structure of the chromatophore could not be determined, neither could vacuoles or a pyrenoid be detected. A large brick-red eye-spot is prominent near the anterior end, and four cilia are present. Either four, eight or sixteen zoospores are formed from the repeated bipartition of the contents of a cell. They are liberated by breaking through the gelatinous membrane while still enclosed in an inner gelatinous envelope; this, however, is quite invisible without use of reagents. They remain in this membrane for a relatively long period, moving almost continually. Some half dozen of these clusters were observed to move for three hours, but the entire period of motion was not determined. During these movements they were observed to change their shapes, becoming more elongated in form, as in *fig. 14*.

On coming to rest they soon become rounded, and begin to divide. Usually they develop directly into a disk or cluster, as the case may be, but on agar with 0.4 per cent. Knop's solution several cases were noticed where two or four zoospores were formed directly from these cells, before any other division had occurred (*fig. 15*). These zoospores were not seen to be liberated, but they appeared to be perfect, as each showed distinctly an eye-spot.

In the thallus the zoospores are generally formed in the thickened portion near the center and rarely near the edge. Often the whole center of the thallus has produced zoospores, leaving the cells perfectly empty, and many individuals were noticed on the side of the glass that were ring-shaped, as if the center were entirely gone.

Whereas in most other algæ which reproduce by means of zoospores these are usually formed when transferred from nutritive solution to water, or from stronger nutritive solution to weaker, or from agar cultures to liquid, in this species they are formed when the thallus is subjected to any sudden change. As might be expected, they are produced when the disc is transferred from agar to Knop's solution, but they are also produced when transferred from water to Knop's solution, and when transferred from water to agar. They may be formed within twenty-four hours after these changes are made, but often they do not appear until the second day. In some cases nearly the whole thallus was seen to produce zoospores.

After repeated attempts to find the principles governing the production of the zoospores, no results were obtained farther than that, within certain limits, the greater the change of conditions the greater the number of zoospores and the sooner their formation.

Though this alga greatly resembles Coleochæte in appearance, it really is of much lower organization. Its well developed disk form, instead of being inherent in the alga, as in Pediastrum or possibly Coleochæte, apparently is due only to contact, for, whatever the other conditions may be, it cannot be made to assume this form without a solid substratum.

The fact that it so easily reverts to a unicellular state in which there is no differentiation of cells, but each is capable of carrying on all life functions for itself, and the fact that zoospores may arise directly from the germinating zoospores, show a development but little above the strictly unicellular forms. It may possibly be regarded as one of those organisms, as yet so little known, which are transition forms between the lower and the higher algæ, and may assume the nature of the one or the other according to external circumstances.

That it has been found under conditions so very unlike is not easily explained, and the fact that it has been so rarely found, and then in regions so widely separated, is an interesting problem in distribution.—JULIA W. SNOW, *University of Michigan.*

*** The work upon which the foregoing paper is based was done in the spring of 1898, while the author held a fellowship given to the Botanical Department by Mr. D. M. Ferry, of Detroit.

EXPLANATION OF PLATE VII.

FIG. 1. Portion of a thallus. × 300.

FIG. 2. Thallus in cross section. × 66.

FIG. 3. Section at the center of a young thallus. × 875.

FIG. 4. Section at the margin of a young thallus. × 875.

FIG. 5. Section through the center of an older thallus. × 300.

FIG. 6. Portion of the surface of a disk ten days after removal from glass. × 300.

FIGS. 7, 8. Young thalli developing when attached to glass. × 875.

FIGS. 9–12. Young thalli when not attached to some solid substratum. *Fig. 9*, × 300; *figs. 10–12*, × 875.

FIG. 13. Zoospores. × 875.

FIG. 14. Shape sometimes assumed by zoospores before liberation and occasionally retained after liberation. × 875.

FIG. 15. Zoospores arising directly from germinating zoospores. × 875.

RECENT WORK ON THE LIFE-HISTORY OF THE RHODOPHYCEÆ.

IN Oltmanns' paper upon the life-history of the Rhodophyceæ[1] we have the most recent general expression of opinion on the difficult problems of sexual reproduction and the attendant phenomena of the development of the cystocarp found in this peculiar group of plants. His is the fourth contribution attempting to cover a broad horizon and dealing with the questions in their totality as illustrated throughout the entire class. The three papers that preceded his account were by Bornet and Thuret in 1867, Janczewski in 1876, and Schmitz in 1883.

Of these three papers the first two gave descriptions of the histology and development of the cystocarps of several types, which, for clearness of expression and beauty of illustration, have not been surpassed. One can only express the greatest admiration for the work of Bornet and Thuret, but their investigations, as also those of Janczewski, came before the time of critical cytological study, and consequently

[1] Zur Entwickelungsgeschichte der Florideen. Bot. Zeit. 56^{1}: 99. 1898.